

## Description

Method and base station for assigning channels for radio transmission

5 The invention relates to a method and a base station for assigning channels for radio transmission between a subscriber station and a base station in mobile radio systems, in particular.

10 In a GSM system (Global System for Mobile Communications), a combination of frequency division multiple access (FDMA) and time division multiple access (TDMA) is used. The available frequency band is  
15 divided into an uplink band (890 MHz - 915 MHz) and a downlink band (935 MHz - 960 MHz) with a band spacing of 45 MHz when using a frequency division duplex (FDD) method. Each of these bands is subdivided into 124 individual frequency channels at a spacing of 200 kHz.  
20 Each frequency channel is unambiguously numbered and a pair of equal numbers from the uplink band and the downlink band in each case forms one duplex channel with a fixed duplex spacing of 45 MHz. This is the FDMA component. Within each frequency channel, a TDMA method  
25 with 8 timeslots per timeslot frame is used, the timeslot frames of the uplink band being sent with three timeslots delay compared with the timeslot frames of the downlink band for reducing the switching effort. A subscriber station in each case uses the timeslot  
30 having the same timeslot number (TN) in the uplink band and in the downlink band. This correspondingly also applies to the expanded GSM frequency bands and for DCS (Digital Communication System) 1800.

In each timeslot of a timeslot frame, databursts of the same length are sent. A normal burst (NB) contains error-protection coded and encrypted user data, symmetrically separated by a so-called midamble (MA)  
5 for estimating the channel characteristics and corresponding channel

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equalization. The timeslot number, the midamble number and the channel type (control channel, traffic channel ...) apply both to the uplink band and to the downlink band in the GSM system.

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This means that the logical or physical channel allocated to a subscriber station in a GSM system, is unambiguously specified in the uplink band and in the downlink band even without information on uplink or  
10 downlink, by means of a channel description.

If an optionally applicable frequency hopping is used during which the frequency is changed periodically during the transmission in order to compensate for  
15 frequency-selective disturbances, the frequency hopping parameters also apply to the uplink band and the downlink band.

In a DECT (Digital Enhanced Cordless Telephone) system which also uses a combination of FDMA and TDMA at the radio interface, the total available frequency band (between 1880 MHz and 1990 MHz) is used in both directions, in contrast to the GSM system, transmission and reception taking place in different timeslots for separating uplink from downlink. This is called a TDD (time division duplex) mode. According to the DECT standard, the first 12 timeslots of a DECT frame are provided for the downlink and the second 12 timeslots of the DECT frame are provided for the uplink and there  
25 is always a spacing of 12 timeslots between uplink and downlink of a voice connection. These 12 timeslots correspond to a period of 5 ms because the DECT system operates with a fixed switching point between downlink and uplink. If a DECT subscriber station requests a  
30 voice channel (full slot) on a particular timeslot, for example timeslot 18, and on a particular frequency  $f_x$ , the uplink channel is unambiguously specified in accordance with the DECT standard. The uplink channel is on the same frequency  $f_x$  and on timeslot 6 (18 - 12).

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Future radio communications systems such as UMTS (Universal Mobile Telecommunication System) which, among other things, will offer a transmission capacity according to the ISDN for services such as video telephony and broadband connections and will be used in the text which follows for representing the technical background of the invention without restricting the general applicability of the use of the invention, are based on the transmission channels being separated by spread-spectrum codes. The significant feature of a code division multiple access (CDMA) method is the transmission of a narrow-band radio signal in a wide frequency spectrum, the narrow-band signal being spread to a wideband signal by means of a suitable coding rule. In the UMTS system, two modes are provided, the FDD mode and the TDD mode. The FDD mode is a broadband CDMA characterized by the degrees of freedom of frequency and spread-spectrum code and the TDD mode is a TD/CDMA method characterized by the degrees of freedom of frequency, timeslot and spread-spectrum code. In the latter, the multiple access is achieved by means of a broadband TDMA/FDMA system in which, in turn, a multiple access according to the CDMA method is allowed in certain timeslots of a timeslot frame. In the TDD mode, one or more variable switching points between uplink and downlink are provided within a timeslot frame, in order to achieve better management of the scarce frequency resources.

In the UMTS system, different frequency bands are provided, unpaired bands and paired bands. From current perspective, the unpaired bands are reserved for the TDD mode and the paired bands are exclusively reserved for the FDD mode. One unpaired band is in the frequency range of 1900 MHz to 1920 MHz and the other unpaired band is in the frequency range of 2010 MHz to 2025 MHz. The uplink band of the paired band is in the frequency range of 1920 MHz to 1980 MHz and the downlink band of the paired band is in the range of 2110 MHz to

2170 MHz. The duplex band thus has a duplex spacing of  
190 MHz. The

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frequency bands are divided into frequencies of 5-MHz bandwidth each. The unpaired bands thus have four and three frequencies and the paired band has 12 uplink frequencies and 12 downlink frequencies. Figure 3 provides a representation of the frequency bands and how they are divided up.

When symmetric services are requested such as, for example, services with data rates of 64 kBit/s, 144 kbit/s or higher (real-time service) or also voice services, the same data rates must be transmitted in the downlink band as in the uplink band.

In the case of asymmetric utilization of the paired band, in contrast, the downlink band is, as a rule, heavily loaded and the uplink band is loaded only slightly. This can be expected, in particular, in the case of database enquiries such as, for example, from the Internet. In the case of asymmetric data services, it is assumed that a high data rate is required in the downlink and a low data rate in the uplink. Naturally, the situation can also occur the other way around, for example when sending a fax from a subscriber station.

For this purpose, it has already been proposed to also allow a TDD mode in the uplink band of the paired band from the UMTS as a result of which a higher capacity utilization of the frequency resources is supposed to be achievable overall. This requires a new protocol for an unambiguous channel description which must be implemented both in the subscriber stations and in the base stations.

The invention is, therefore, based on the object of performing an efficient description of the channels with little signaling expenditure.

This object is achieved by means of the method according to claim 1 and the base station according to

claim 8. Advantageous embodiments and

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developments of the invention are the subject matter of the dependent claims.

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The method for assigning channels for a radio transmission between a subscriber station and a base station of a radio communications system provides that

- a number of channel resources are unambiguously assigned to the subscriber station by means of a common channel description transmitted to it for the radio transmission
- and the channel description contains information on the order of utilization of the channel resources during the radio transmission.

According to a further development of the invention, it is provided that the order of the utilization of the channel resources is specified by the order of the information of the individual channel resources within the channel description.

Since, on the one hand, the fixed duplex spacing between the uplink band and the downlink band in the FDD mode is cancelled by dividing the paired band into FDD and TDD and, on the other hand, any fixed allocation of the timeslots to downlink and uplink within a timeslot frame is cancelled with respect to a simultaneous support of symmetric and asymmetric services in the TDD mode, the position and spacing of the downlink channel and the uplink channel must always be unambiguously defined in a channel description for a channel assignment, independently of the transmission resource used.

For this purpose, the uplink channel and downlink channel are described one after the other in a common information element and sent from the base station to a subscriber station in a system information in the dedicated control channel (DCCH) in an embodiment of the invention. According to a further embodiment, two



information elements are set up for the uplink channel  
and the downlink channel and are

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transmitted separately. According to a further embodiment, a channel assignment is carried out by describing only one channel when, for example, the uplink and the downlink channel only differ in the timeslot number and all other parameters are identical. According to a further embodiment, both channels are described in a common information element and a flag indicates what applies to the uplink channel and what applies to the downlink channel. This corresponds to a new transmission parameter UL/DL within the system information message. A further channel description according to the invention is organized in such a manner that one information element describes the uplink channel whereas the downlink channel is described by a new transmission parameter. Having regard to multicarrier multifrequency mobile radio systems, the frequency spacings between uplink channel and downlink channel are specified in an information element in a further embodiment. In a case where, for example, more than only one physical channel is to be provided to the user for the purpose of real-time data transmission in one direction, the order in which the channels are to be used is unambiguously specified in the channel description in a further embodiment. In a scaling down of this proposal, the order of channel utilization can be given by specifying the relevant spread-spectrum code or also by specifying the frequency.

In the case of a channel change, either only the downlink channel or only the uplink channel can be changed which is why, according to the invention, a channel description is only provided for the downlink channel or only for the uplink channel in these cases, and not for both directions at the same time.

According to the invention, the channel description for FDD and TDD can also be combined, for example a channel

description for the uplink channel in the FDD mode with a channel description for the downlink in the TDD mode.

In the text which follows, the invention will be explained in greater detail with reference to exemplary embodiments of the UMTS system and the associated drawing, in which:

Figure 1 shows a general representation of a radio interface in a radio communications system,

Figure 2 shows a representation of the frequency bands in the UMTS system,

Figure 3 shows an exemplary frequency band distribution in the paired band,

Figure 4 shows a timeslot frame with a variable switching point between uplink and downlink,

Figure 5 shows a timeslot frame with a number of switching points and CDMA multiple access,

Figure 6 shows parameters of a channel description without using a frequency hopping method in the TDD mode of UMTS,

Figure 7 shows a general representation of a channel description according to figure 6 by means of two information elements within a system information item,

Figure 8 shows a variant of the channel description with a common information element for both channel directions,

Figure 9 shows a further variant of the channel description with only one information element and with a flag being set,

Figure 10 shows a further variant of a channel description with only one information element with fixed reference to uplink and downlink,

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Figure 11 shows a general channel description for an uplink channel,

5 Figure 12 shows a shortened channel description according to figure 11 for channels which only differ in their spread-spectrum code,

10 Figure 13 shows a general channel description for a downlink channel,

Figure 14 shows parameters for a channel description in the FDD mode of UMTS, and

15 Figure 15 shows a variant of a channel description by means of two information elements for each channel in the FDD mode of UMTS.

20 In a UMTS mobile radio network used as an example of a radio communications system, a subscriber station MS and a higher-level base station MS, which is to be used as an example of a station of a radio cell, of a sector of a radio cell or of a network itself, communicate, according to figure 1, via a radio interface downlink DL and uplink UL, either in the TDD mode or in the FDD mode of UMTS. The base station BS can set up a connection to another subscriber station MS, for example a mobile station or any other mobile or stationary terminal via a further radio interface, not shown.

30 Figure 3 shows exemplary band partitioning for a frequency band according to figure 2 (prior art). According to this, five frequencies of the uplink paired band have been released for TDD instead of FDD, namely frequencies f6, f9, f10, f14 and f15. Whereas the maximum possible data rate is retained for the downlink in the FDD mode, it is reduced for the uplink. This has no noticeable consequences in the case of asymmetric utilization of data services in

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the FDD mode which frequently demand a higher bit rate  
for the downlink than for the uplink,

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for example during a data transfer from the Internet. In this case, 12 frequencies are now provided for the utilization of TDD, instead of 7 frequencies, in this time, which means that the available frequency band can be better utilized overall.

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However, such or any other type of partitioning of the channels in FDD and TDD eliminates the fixed duplex spacing of the FDD channels in the paired band between uplink and downlink which is why the frequency spacing of a downlink channel and an uplink channel must be specified in the case of an assignment. Similarly, specification is necessary in the TDD mode with regard to the simultaneous support of symmetric and asymmetric services.

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The TDD mode operates with a timeslot structure, one timeslot frame with a frame period of 10 ms being subdivided into 16 timeslots. In each of the timeslots, the subscribers are distinguished by different spread-spectrum codes (CDMA components). In TDD mode, 16 spread-spectrum codes are provided.

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An essential advantage of the TDD mode is the variable switching point between downlink and uplink within a timeslot frame. The variable switching points make it possible to use the available resources more efficiently for asymmetric services. For example, the switching point can be adjusted in such a manner that 12 timeslots of the timeslot frame are available for the downlink DL and the remaining 4 timeslots are available for the uplink UL (figure 4). Subtracting two timeslots for control channels, a total of 14 timeslots would thus still be available for traffic channels, 11 timeslots of which could be allocated to the downlink and 3 timeslots to the uplink. In this case, the TDD mode can support higher data rates in the downlink direction than in the uplink direction. The switching point SP can be adjusted by the network by "operations and

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~~maintenance~~" or also automatically varied in accordance with the current traffic volume.

It is also possible to provide a number of switching points within a timeslot frame. Figure 5 shows 3 switching points SP1, SP2, SP3. In addition, it shows that each timeslot ts supports 16 channels which can be distinguished by different spread-spectrum codes 1 to 16. The flexibility of the switching points eliminates any rigid relationship between the timeslots ts such as it exists, for example, in the DECT system.

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A system with 3 switching points within a timeslot frame according to figure 5 will be considered in greater detail. If the uplink timeslot 15 is allocated to a subscriber station MS for a voice link, the downlink timeslot can be allocated to the subscriber station MS either from the range of timeslot 1 to 4 or from the range of timeslot 9 to 13. These timeslots ts are either less than 8 timeslots or more than 8 timeslots away from timeslot 15, 8 timeslots corresponding to a period of 5 ms, i.e. one half of the frame period of a 10-ms timeslot frame. This means that, with a variable switching point SP, the uplink channel and the downlink channel must be unambiguously specified during the channel assignment.

In figure 6, the parameters for a channel description in the TDD mode of UMTS without frequency hopping are designated in greater detail. A specific physical channel can be accurately defined with values for the type of the logical channel/subchannel, for the timeslot number TN, for the code group, for the spread-spectrum code, for the midamble MA and for the frequency f.

If a frequency hopping method is used, the frequency list, the hop sequence number and the Mobile Allocation Index Offset (MAIO) are specified



in the channel description. Furthermore, the possibility exists that the parameters for uplink and for downlink are also differentiated.

- 5 The actual parameters of a channel description in the case of the request for a voice channel are, for example:

10	Uplink:	Channel type: full-slot traffic channel, voice
		Timeslot: 15
		Code group: 5
		Spread-spectrum code: 10
		Midamble: 7
15		Frequency: 3
	Downlink:	Channel type: full-slot traffic channel, voice
		Timeslot: 10
20		Code group: 5
		Spread-spectrum code: 10
		Midamble: 7
		Frequency: 3

- 25 In a first embodiment of the invention, the uplink channel and the downlink channel are described one after the other in two separate optional information elements IEI, and transmitted from the base station to a subscriber station in an information item in the  
30 dedicated control channel (DCCH).

A channel description for the uplink channel UL is performed in a first information element IEI and a channel description for the downlink channel DL is  
35 performed in a second information element IEI.

Figure 7 reproduces the identical format of the information elements IEI(UL) and IEI(DL) in structured form as part of a message of the DCCH. A message is a

block of coherent data built up of a number of bits. 8 bits are in each case combined to form one octet. Octets thus form the elements from which a message is built up.

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5 In the first octet, bits 1 to 7 contain the message type, namely: information elements IEI for the separate channel description in the uplink UL and in the downlink DL, respectively. Bit 8 is free. In the second

10 octet, bits 1 to 4 specify the timeslot number TN in the uplink UL and the downlink DL, respectively, bits 5 to 8 specify the channel type which, as already mentioned, can be the same in the uplink UL and downlink DL. In the third octet, bits 1 to 4 specify

15 the spread-spectrum code and bits 5 to 8 specify the midamble number MA, in the uplink UL and downlink DL in each case. In the fourth octet, bits 1 to 8 are set for identifying the code group in the uplink UL and downlink DL, respectively, and the bits in the fifth octet designate the frequency of the channels in the uplink UL and the downlink DL. Each channel is thus unambiguously characterized.

20 In a case where an uplink channel and a downlink channel only differ, for example, by a timeslot number, a channel description can also be implemented by only one information element IEI (DL\_UL). The information element IEI (DL\_UL) then specifies that downlink DL and uplink UL differ by 8 timeslots TN and the parameters

25 of the downlink DL and uplink UL are otherwise identical. Such an information element IEI (DL\_UL) is shown in figure 8.

30 Another solution consists in that also only one information element IEI is added to the channel description and flags in bit 8 in the 5th and 9th octet mark which description applies to the uplink channel UL and which applies to the downlink channel DL. Figure 9 shows an example of this.

35 In a further variant it is provided to specify that the first channel description, for example, relates to the uplink channel UL and other parameters describe the downlink channel DL. The information element IEI

according to figure 10 specifies such a channel description.

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In the case of a multicarrier base station and a multicarrier subscriber station, the frequencies for uplink UL and downlink DL can also be different, for example:

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Uplink: Channel type: full-slot traffic channel,  
voice

Timeslot: 15

Code group: 3

10

Spread-spectrum code: 10

Midamble: 7

Frequency: 5

Downlink: Channel type: full-slot traffic channel,  
voice

15

Timeslot: 10

Code group: 3

Spread-spectrum code: 7

Midamble: 4

20

Frequency: 3

Apart from voice services, there are also data services which can have a higher or lower rate. In the case of a real-time service, the same number of resources must be provided for the uplink channel and the downlink channel. In the case of a 144-kbit/s real time service, 4 channels are needed in each direction. All channels can have almost the same parameters with the exception of the spread-spectrum code. Naturally, a number of parameters can also be different.

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The appearance of a general representation of a channel description for the uplink channel UL for a 144-kbit/s real-time service could correspond, for example, to an information element IEI(UL) according to figure 11. It must be noted that the order in which channels 1 to 4 are to be used must be unambiguously specified in the channel description if more than one physical channel is provided in one direction.

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There is also the possibility of specifying a shortened channel description according to figure 12 with an information element IEI(UL) if the 4 uplink channels only differ in the spread-spectrum code and, accordingly, the order of channel use is governed by this spread-spectrum code information. The order also specifies the order in which the data are transmitted. This information is significant, in particular, in the case of data with higher bit rates. There is a so-called priority list.

For the associated downlink channel DL, in contrast, the channel description could be of a general nature. An example of this is shown by the information element IEI(DL) according to figure 13.

As has already been explained, not all uplink frequency channels and downlink frequency channels have a fixed duplex spacing from one another any longer due to the utilization of TDD in the paired band. For this reason, the uplink channel UL and downlink channel DL are also determined unambiguously in a channel description in the FDD mode in a further embodiment of the invention. As in the TDD mode, information elements can be additionally set up for each frequency channel, for example, or the description of one frequency channel is included in the description of the other frequency channel. Naturally, reversion to other variants already specified are also possible, for example to the use of a flag.

An example of this is given below:

Uplink:	Channel type: Voice/data
	(service 1, service 2 etc.)
	Spread-spectrum code: 10
	Code group: 10
	Frequency: 3

Downlink: Channel type: Voice/data  
(service 1, service 2 etc.)  
Spread-spectrum code: 10  
Code group: 11

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Frequency: 5

A channel in the FDD mode is characterized as specific physical channel, according to figure 14, via the following parameters: type of logical channel/subchannel, code group, spread-spectrum code and frequency. The information elements for an uplink channel IEI(UL) and a downlink channel IEI(DL) are specified in figure 15 by way of example.

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According to a further variant, the channel description for the FDD channels can also be combined in a single information element IEI:

15

Uplink: Channel type: Voice/data  
(service 1, service 2 etc.)  
Spread-spectrum code: 10  
Code group: 10  
Frequency: 3

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Downlink: Channel type: Voice/data  
(service 1, service 2 etc.)  
Spread-spectrum code: 10  
Code group: 11  
Frequency: 5

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The information elements IEI for FDD and TDD and uplink and downlink can be different.



## Patent Claims

1. A method for assigning channels for radio transmission between a subscriber station and a base station of a radio communications system,
- in which a number of channel resources are unambiguously assigned to the subscriber station by means of a common channel description transmitted to it for the radio transmission
- and in which the channel description contains information on the order of utilization of the channel resources during the radio transmission.
2. The method as claimed in claim 1, in which the order of the utilization of the channel resources is specified by the order of the information on the individual channel resources within the channel description.
3. The method as claimed in claim 2, in which the order of the utilization of the channel resources is specified by information relating to timeslots assigned in each case, to spread-spectrum codes assigned in each case and/or to frequencies assigned in each case.
4. The method as claimed in one of claims 1 to 3, characterized in that an uplink channel (UL) and a downlink channel (DL) are described one after the other and a coherent channel description is sent as a message from the base station (BS) to the subscriber station (MS).
5. The method as claimed in one of claims 1 to 3, characterized in that an uplink channel (UL) and a downlink channel (DL) are described separately and

are sent / as separate messages from the base  
station (BS) to the subscriber station (MS).

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- 5 6. The method as claimed in one of claims 1 to 3,  
characterized in that an uplink channel (UL) and a  
downlink channel (DL) are described in a common  
channel description which is sent as a message, a  
flag indicating the parts of the description which  
relate to the uplink channel (UL) and to the  
downlink channel (DL).
- 10 7. The method as claimed in one of the preceding  
claims, characterized in that in a case where only  
one channel is changed, the downlink channel (DL)  
or the uplink channel (UL), only the description  
of this channel (DL/UL) is sent.
- 15 8. A base station for a radio communications system  
- comprising a facility for assigning channels  
for a radio transmission with a subscriber  
station,  
- the channel assignment facility of which is  
20 provided for transmitting a common channel  
description to the subscriber station for  
assigning a number of channel resources for the  
radio transmission,  
- and the channel assignment facility of which  
25 generates the channel description in such a  
manner that it contains information on the  
order of utilization of the channel resources  
during the radio transmission.

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Figure 1

Key 1    prior art

Figure 2

Key 1    prior art

Figure 3

Key 1    TDD mode  
          FDD mode

Figure 4

Key 1    prior art  
Key 2    timeslot number

Figure 5

Key 1    prior art  
Key 2    timeslot number  
Key 3    code number

Figure 6

Key 1    meaning  
Key 2    values  
Key 4    from top to bottom, channel type/subchannel  
         timeslot  
         .....code group  
         .....spread-spectrum code  
         midamble  
         frequency

Figure 7

Key 1 bit number  
 Key 2 octet number  
 Key 3 from top to bottom, channel description IEI(UL)  
           channel type/subchannel TN(DL UL)  
           MA (DL, UL) spread-spectrum code (UL)  
           Code group (UL)  
           Frequency (UL)

Figure 8

Key 1 bit number  
 Key 2 octet number  
 Key 3 from top to bottom, channel description IEI(UL)  
           channel type/subchannel TN(DL UL)  
           MA (DL, UL) spread-spectrum code (DL UL)  
           Code group (DL, UL)  
           Frequency (DL, UL)

Figure 9

Key 1 bit number  
 Key 2 octet number  
 Key 3 from top to bottom, channel description IEI  
           channel type/subchannel TN  
           MA spread-spectrum code  
           Code group  
           Frequency  
           channel type/subchannel TN  
           MA spread-spectrum code  
           Code group  
           Frequency

Figure 10

Key 1 bit number  
 Key 2 octet number  
 Key 3 from top to bottom, channel description IEI  
           channel type/subchannel TN (UL)  
           MA (UL) spread-spectrum code (UL)

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Code group (UL)  
 Frequency (UL)  
 UL/DL                      TN  
 MA                      spread-spectrum code  
 Code group  
 Frequency

Figure 11

Key 1    bit number  
 Key 2    octet number  
 Key 3    from top to bottom, channel description IEI (UL)  
           channel type/subchannel                      TN  
           MA                      spread-spectrum code  
           Code group  
           Frequency  
           2nd channel                      TN 2  
           MA 2                      spread-spectrum code 2  
           Code group 2  
           Frequency 2  
           3rd channel                      TN 3  
           MA 3                      spread-spectrum code 3  
           Code group 3  
           Frequency 3  
           4th channel                      TN 4  
           MA 4                      spread-spectrum code 4  
           Code group 4  
           Frequency 4

Figure 12

Key 1    bit number  
 Key 2    octet number  
 Key 3    channel description    IEI  
           channel type/subchannel                      TN  
           MA                      spread-spectrum code  
           Spread-spectrum code 2 - spread-spectrum code 3  
           Spread-spectrum code 4 - free  
           Code group  
           Frequency

Figure 13

Key 1	bit number	
Key 2	octet number	
Key 3	from top to bottom, channel description IEI (DL)	
	channel type/subchannel	TN
	MA	spread-spectrum code
	Code group	
	Frequency	
	2nd channel	TN 2
	MA 2	spread-spectrum code 2
	Code group 2	
	Frequency 2	
	3rd channel	TN 3
	MA 3	spread-spectrum code 3
	Code group 3	
	Frequency 3	
	4th channel	TN 4
	MA 4	spread-spectrum code 4
	Code group 4	
	Frequency 4	

Figure 14

Key 1	meaning
Key 2	values
Key 3	channel type/subchannel
	code group
	spread-spectrum code
	frequency

Figure 15

Key 1	bit number
Key 2	octet number
Key 3	channel description IEI (UL)
	channel type/subchannel
	spread-spectrum code (UL)

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channel description IEI (DL)
channel type/subchannel
spread-spectrum code (DL)
code group (DL)
frequency (DL)
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